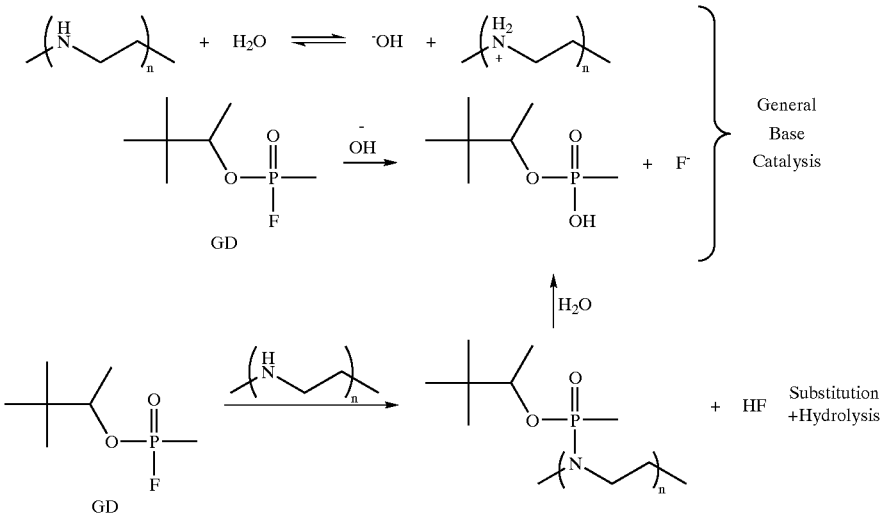
it is likely that the polyalkenimines are active as nucleophiles or else accelerate hydrolysis through general base catalysis (Scheme 2).

Scheme 2.
Hydrolyses of soman (GD) by polyalkenimines



[0063] Many of the listed active TSPs contain water, and the in model reactions with a GD simulant, diisopropylfluorophosphate, (DFP), the products have FT-IR and ^{31}p NMR spectra that are consistent with hydrolysis. Another possibility is that adventitious adsorbed water in formulations that did not have water added directly act as a reagent for this hydrolysis.

[0064] The increase in protection for the polyalkenimines was impressive against GD vapor as seen by the decrease in total ng that breakthrough the active TSP as compared to SERPACWA (ICD3004) (**FIG. 6**). **FIG. 6** shows a total amount of GD vapor that penetrates a 0.15 mm thick aTSP barrier in 20 hr. ICD3004 (SERPACWA) is off scale with a value of 6672 ng.

[0065] Many of the formulations reduce the amount of GD vapor by >99%. Most samples display significantly (P=0.05) increased protection compared to SERPACWA (ICD 3004) in the penetration cell model against GD vapor.

[0066] The increase in protection for aTSPs formulations containing polyalkenimines was also remarkable against HD vapor as demonstrated by the decrease in total ng that break through the active TSP in 20 hours as compared to SERPACWA (ICD3004) (**FIG. 7**).

[0067] As clearly seen in **FIG. 7**, most of the formulations containing polyalkenimines have shown outstanding protection against HD vapor in the penetration cell model. Many offer significantly better (P=0.05) protection against HD vapor compared to SERPACWA (ICD 3004).

[0068] To roughly determine the resistance of aTSPs containing polyalkenimines, the M8 paper test was performed. All formulations tested against HD liquid proved impervious over the duration of the test (360 min) but showed variable resistance against GD liquid (**FIG. 8**).

[0069] Limited penetration cell testing has also been accomplished against HD and GD liquid. In this module, the aforementioned a TSPs performed well against GD but were ineffective against HD (**FIG. 9**).

[0070] In addition to the penetration cell model, certain active TSP containing polyalkenimines were tested in the headspace solid phase micro-extraction gas chromatography/mass spectrometry (HS-SPME/GC-MS) test against HD. In this module significant efficacy was seen against HD, GD, and VX (**FIG. 10**). For **FIG. 10**, evaluation of active TSPs containing polyalkenimines against HD, GD, and VX liquid using headspace solid phase micro-extraction gas chromatography/mass spectrometry (HS-SPME-GC/MS). Percent of Control is the ratio (expressed as %) of the headspace concentration of the CWA determined for each formulation divided by the headspace concentration determined for SERPACWA.

[0071] Possible neutralization pathways of these amines, polyalkenimines, and derivatives were probed using NMR with diisopropylfluorophosphate (DFP) as a GD simulant and CEES as an HD simulant. To determine the relative activity of different polyalkenimines towards organophosphates, the first experiments monitored the hydrolysis of DFP in deuterated water (D_2O). ^{31}P NMR spectra were obtained displaying both the native DFP (d, −11.6 ppm) and it hydrolysis product (s, −2.5 ppm). These spectra were obtained at regular intervals over 14 hours (**FIG. 2**). The extent of hydrolysis was determined by taking the ratio of the integrations of the signals for DFP and its hydrolysis product. By plotting the percent hydrolysis versus time, we were able to perform an initial ranking of the polyalkenimines (**FIG. 11**).

[0072] To determine the possible reaction pathways for the neutralization of HD by polyalkenimines, we performed a series of experiments measuring the degree of hydrolysis in